MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2018/2019

EOP 3056 – OPTICAL METROLOGY AND TESTING

(OPE)

14th- March 2019

9.00 A.M – 11.00A.M

(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 5 pages with 4 Questions only.
2. Attempt **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please print all your answers in the Answer Booklet provided.

Question 1

(a) The convex surface of radius 3.00 m of a lens rests on the concave spherical surface of radius 4.00 m.If Newton's rings are viewed with reflected light of wavelength 6×10^{-7} m.Calculate (i) the diameter of the 12th dark ring and 13th bright ring, (ii) the difference of square of the diameters of successive rings.

[10 marks]

(b) Newton's rings are formed by reflection in the air film between a plane surface and a convex surface of radius 100 cm.If the squares of radii of six bright rings be 100 , 152 , 198 , 248 , 302 and $350\times10^{-4}\,cm^{-2}$, calculate of the wavelength of the light.

[7 marks]

(c) When movable mirror of Michelson's interferometer is shifted by 0.00275cm,the shift of 100 fringes is observed.Calculate the wavelength of light in $\overset{0}{A}$ and state its colour.

[3 marks]

(d) Two Fabry Perot Interferometer have equal plate separation: but the coefficients of reflections are 0.80 and 0.90.Deduce the relative widths of maxima in the two cases and show it qualitatively with a diagram.

[5 marks]

Continued .....

Question 2

As an equipment maker, you are required to examine the fluid temperature variation within a chamber. The design is given with 2 transparent window to view fluid temperature and flow condition. It is observed that the steady state relationship of refractive index, n with temperature, T is:

$$n = T_0 - kT \ , k > 0 \ .$$

a. Suggest a suitable technique to measure the refractive index change. Explain why you choose this technique.

[6 marks]

b. Using a diagram, illustrate the measurement platform you suggested for this measurement.

[6 marks]

c. Explain the principles behind the measurement platform.

[6 marks]

d. State the assumptions in making the measurement.

[3 marks]

e. Explain using a flow chart, the methodology of finding T, using the measurement.

[4 marks]

Continued .....

Question 3

As a quality assurance engineer, you are required to ensure the quality of a large (3 m in diameter) parabolic mirror. Specifically, the testing and quality evaluation can be digitized using a Shack-Hartmann Wavefront Sensor (SHWS) System (using lenslet array).

a. Using a diagram, explain how the SHWS can be used in the testing and quality assurance. For every slope measurement of the wavefront *S*, describe the phase of the wavefront as a function of the slope measurement (using zonal method).

[12 marks]

b. If the system can be simplified in linear equations form,

$$\vec{y} = A\vec{x};$$

where vector $\vec{y}$ is the slope measurement over M grid points (in one direction over a square grid, m x m = M), vector $\vec{x}$ is the phase of the wavefront over the lenslet surface.

Given the slope measured as below, find the phase of the wavefront. Interpret the results.

$$\vec{y} = \begin{bmatrix} 3 \\ 2 \\ 1 \\ 2 \\ 3 \end{bmatrix}; \qquad A^{-1} = \begin{bmatrix} 0.0195 & 0 & 0 & 0 & 0 \\ 0 & 0.0195 & 0 & 0 & 0 \\ 0 & 0 & 0.0031 & 0 & 0 \\ 0 & 0 & 0 & 0.0031 & 0 \\ 0 & 0 & 0 & 0 & 0.0098 \end{bmatrix}.$$

[6 marks]

c. Describe cooperative target with proper diagram

[7 marks]

Continued .....

Question 4

a. Using a diagram, explain how a passive system of your choice (give the name of the system) that can be used to measure 3D range data.

[13 marks]

b. Suppose the system suggested in Q4 (a) indicated a relationship between the expected range data (3D) as $\vec{Y}$ with the range of measured vector $\vec{x}$.

$$\vec{Y} = A\vec{x}$$

where A is the transformation matrix. Suggest a technique to estimate vector $\vec{Y}$.

[5 marks]

c. Using a diagram, explain double exposure holographic interferometry.

[7 marks]

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